How Many Children Does It Take to Replace Their Parents?
Variation in Replacement Fertility as an Indicator
of Child Survival and Gender Status

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I. Abstract

Replacement fertility is a key demographic concept often misconstrued as a constant 2.1 children per woman. Actually it varies by population and over time, from as low as 2.06 children per woman to well over 3. High replacement fertility mostly reflects low survival of female infants (i.e. future childbearers) to their own reproductive age. High sex ratios at birth can also raise replacement fertility values somewhat. Replacement fertility is generally perceived as relevant only to population equilibrium or decline. Its variation can, however, illuminate child and adolescent survival and some aspects of female status when its components are disaggregated. Those who study and work on population can clarify for policymakers the importance of tracking and publicizing variation and change in replacement fertility rates. This concept can then evolve from a hypothetical "target" on which total fertility rates should converge to an indicator of young people's health and female well-being.

II. Introduction

Replacement fertility — the number of births that will guarantee the average couple's replacement in a population — is a key demographic concept that is widely misconstrued as a universal and unchanging value worldwide: 2.1 children per couple. (*Total fertility*, by contrast, is the number of children the average woman has over her lifetime, assuming current birthrates hold steady over that time.) Even some demographers fail to recall that replacement fertility — a function of sex ratios at birth and the survival of children to roughly the middle of their own reproductive lives — is specific to each population and is subject to changing conditions. Moreover, this value varies widely around the world, from somewhat lower than 2.1 in most industrialized countries to higher than three children in a few countries that are among the least developed — and most deadly to the young and female. In three countries, we have found dramatically rising replacement fertility rates over the past decade, a clear response to the phenomenon of rising mortality among young women due to infection at early ages with HIV. These quantifications are based on available data and assume agreement on some methodological questions explored in this paper.

Today, replacement fertility rarely arises outside of discussions of whether a population is headed toward growth, equilibrium or decline. Confined to this demographic ghetto, the concept is neither well understood nor seen as relevant to public health and development. We suggest that replacement fertility can be seen as a simple and useful indicator of both the survival of young people (specifically young women) and to a modest extent the valuation of daughters to parents, and that as such it deserves to be tallied, tracked, explored and discussed on a regular basis as a national, regional and global marker of how (or if) development is proceeding in the public health sector. Those interested in implications of continued population growth in specific countries or in the world have a special reason to monitor replacement fertility: High or increasing values may tell us where death is replaying its ancient role of constraining the growth of humanity.

III. Background

In most of prehistory, when more than half of all children born probably failed to survive to adulthood, replacement fertility must usually have exceeded four or five children per couple, and high birthrates were no barrier to small and stable populations (Cleland, 1993). Without the data needed to construct life tables for most populations until the last century or so, we can only guess at actual values for replacement fertility in the past. It probably varied widely, with some societies experiencing different death rates among infants, children and young adults depending on local conditions related to predators, diseases and conflict.

In times of demographic cataclysm, such as the Black Death in Europe, the depopulation of the Americas after the European encounter, or the Holocaust, replacement fertility rates would logically have risen so high — to a dozen or more children — that few if any women would have been able to give birth to the needed number. At such times the entire concept of replacement fertility loses any meaning. When mortality rates are stratospheric, populations cannot replace themselves no matter what their fertility patterns are. Such demographic free falls are few and far between in human history, however.

The global public health revolution has made high replacement fertility a forgotten aspect of the human past, but if catastrophic death rates ever revisited human populations, the figure could reach such levels again. One rarely expressed objective of those of us who work in public health is to see that such a day never arrives even in the smallest sub-population. And, indeed, most demographic projections are based on the assumption that no increases in replacement fertility rates lie in our future. Some commentators nonetheless question whether certain of the high-variant country-level population projections could unfold with no increases in death rates. Even the United Nations Population Division has implicitly endorsed this line of inquiry by developing a "constant-fertility" projection that produces a world population of 134 trillion people in the year 2300 (United Nations, 2003). The UN demographers acknowledge that this is an impossible scenario, presumably because rising death rates would intervene long before any such population level (requiring a global population density 143 times that of Hong Kong today) could be reached. One way of illustrating this intervention would be to show that replacement fertility rates were rising to meet constant total fertility (held, in the UN scenario, at 2000 rates), a reverse of the convergence that occurs when declining total fertility rates meet constant replacement fertility rates to produce population equilibrium.

IV. Why Replacement Fertility Matters

With rising media and public attention to the growing number of national populations now experiencing below-replacement fertility, it is evident that most writers on the topic believe that replacement fertility rate is a static value, consistently set — rather like the 0º Celsius freezing point of water — at exactly 2.1 children per woman. Kenneth E. Boulding called this impossible one-tenth of a birth the *deci-child* (Boulding, 1964). "The minimum replacement fertility rate is 2.1 children for each couple," a reporter wrote in a recent article about below-replacement fertility in Hong Kong (Kwoh, 2006). The statement is confusing (*each* couple could hardly have 2.1 children), inaccurate (2.1 is not the minimum value for this variable), and typical. These misconceptions have consequences. If a below-replacement fertility country is actually experiencing a replacement fertility rate of less than 2.1, for example, its total fertility rate may not be quite as dire as first appears. Similarly, if a high-fertility country is experiencing a high replacement fertility rate, its population growth may not be proceeding as fast as one might expect — and, tragically, the reason for that is high rates of death in the population. If for no other reason than improving public understanding of an important demographic concept, the fulcrum on which populations grow and shrink, it makes sense to combat the oversimplification of replacement fertility in the news media. This is only one among several reasons to investigate this topic, however.

First, the increase in attention over the last decade to the circumstances of young people in public health generally and in reproductive health specifically draws our attention to the life outcomes of young women and men. Replacement fertility measures in large part the survival of young girls and women in populations to the ages at which they can exercise their sexual and reproductive rights in good health.

Second, rising interest in the phenomenon of demographically "missing girls" and "bare branches" (men without spouses or prospects for a female partner) raises questions about the quantification and implications of the practice of sex-selective abortion in some countries (Hudson and den Boer, 2004). This phenomenon raises replacement fertility rates by requiring parents to have more children to replace themselves in the population, since significantly fewer than half of these children are born female and will ever bear children themselves. If this effect is significant, it may raise the importance of high or rising replacement fertility rates as possible indicators that something artificial is happening to sex ratios at birth that suggests the widespread practice of sex-selective abortion, almost universally a manifestation of son preference among parents.

Third, the substantial boost in private funding for child survival in the past five years suggests the need for indicators that connect such survival to broader demographic and health outcomes. The concept of replacement fertility relates child survival, reproductive health and gender by focusing on the likelihood in each population that 1) a girl is almost as likely as a boy to be born, and 2) that once born she is likely to survive the vicissitudes of life until she herself can be a mother. In areas of civil conflict, high levels of violence against women, or high HIV prevalence, these connections are highly salient and should interest many working in the public health arena.

Fourth, the brutal impact of the HIV/AIDS pandemic in a few countries is reshaping mortality patterns, age structures and population growth rates. It's no longer sufficient to promote the "slowing of population growth." Demographic researchers and policy advocates increasingly must distinguish between the slowing that results from declines in birth rates (ideally reflecting the intentions of parents and others who are sexually active) and the slowing that stems, in some populations, from rising death rates.

Finally, some recent books, commentaries and even news stories (especially related to H5N1 avian flu) have suggested that widespread death on one scale or another could significantly affect demographic trends in this century (Diamond, 2005; Smil, 2005). If this is indeed even a possibility, it would be wise to establish baseline data that would enable us, or those who follow us in the future, to track this demographic variable. It connects birth, death and gender in ways that forecast, at least to some extent, the future of human population and the forces behind its trajectory.

V. Literature, Hypotheses, and Questions

Replacement fertility has long been a basic concept in demography. In 1821, the British writer Piercy Ravenstone used American census data to compute that on average four children per family were needed at that time to maintain a stationary U.S. population, based on his belief that 11 out of every 20 females born survived to middle age and that one of these 11 women remained single (Hutchinson, 1967). Nonetheless, among the demographic texts we consulted only Keyfitz (1977) and Smith (1992) treat the variability of replacement fertility and discuss its derivation from life tables and sex ratios at birth.

In 2003, demographers at Princeton University's Office of Population Research noted the wide variation in global replacement fertility (Espinshade et al., 2003). They used this variation to make the demographic point that many governments targeting total fertility rates of 2.1 might find their populations in decline if that target were reached while replacement fertility rates remained above 2.1. This message seems somewhat out of synch with the prevailing governmental policy focus, following the United Nations International Conference on Population and Development in 1994, away from total fertility targets in population and reproductive health policy. It also seems unrealistic from a demographic and health policy viewpoint. It is likely that those countries able to provide the reproductive health services required for fertility rates to reach 2.1 will also experience increases in the survival of girls and women that will allow replacement fertility to converge at or below that figure. The paper, however, served a valuable purpose in drawing attention to the relatively little-explored variation in replacement fertility. It also offered a brief ranking of selected global, regional and country level replacement fertility rates based on similar data to those we use, and thus similar to our calculations.

In considering replacement fertility and its variation, we outlined various assumptions. One assumption — a requirement, really — was that the variable should be easy to derive from accessible demographic data, so that anyone with access to the Internet could perform the calculations over time, maintaining a database of replacement fertility rates or confirming whether or not our own were accurate. Another assumption is that, once derived, replacement fertility rates could be effectively deconstructed to reveal the components that set them where they are. A third was that both sex-selective abortion and HIV mortality would be easily discerned in the rates of certain populations. We assumed that replacement fertility rates would generally trend over time toward 2.05, the theoretical minimum based on normal sex ratios at birth, but might be rising in countries highly affected by HIV or perhaps facing other unusual increases in mortality.

Beyond these basic assumptions, we had questions: How many people in the world's population live in countries with replacement fertility rates below the commonly assumed 2.1 children per woman? How many people live in countries with rates above that value? What might a ranking of replacement fertility show about global health?

VI. Methodology

We have calculated and ranked countries by their 2005 replacement fertility levels [Table 1], as derived from the 2004 edition of the United Nations Population Division's *World Population Prospects* (United Nations, 2005).

Replacement fertility is easily calculated from demographic data that is readily available for download from the United Nations Population Division at: http://www.box.net/public/UNPD.PEP/folders/2821.html. (last accessed February 1, 2006).

Demographers differ on some of the details of the computation, which is "synthetic" in the same way total fertility is, since we cannot know what the actual probability is that a child born today will survive into future. Survival tables are thus based on a synthesis of the odds of survival that each five-year cohort is experiencing today. Similarly, male survival is a conundrum in thinking about replacement fertility. One male can theoretically parent any number of offspring, but in the real world shortages of males would indeed, to varying degrees, reduce female fertility. Finally, data on sex ratios at birth appear to reflect inadequately the realities of sex-selective abortion, a phenomenon that speaks to the low status of girl children, in some Asian countries. These uncertainties will require consultation with outside demographic experts, a process through which we hope not only to better understand replacement fertility but to stimulate a broader debate on this indicator and to draw attention to its hypothesized value in the demographic and public health arena.

We use a simple formula that requires only two variables for any population, the sex ratio at birth divided by the probability a female newborn will survive to age 27.5 years, to derive the replacement fertility rate for that population.

$$F_r = \frac{R_b/100 + 1}{M_p}$$

F_r is the replacement fertility rate, the time- and population-specific value we are deriving. R_b is the sex ratio at birth, included as a time-specific value for each country in the tables provided by the United Nations Population Division. And M_p is the probability that any female newborn will survive to the midway point between her 27^{th}

and 28th birthdays. This value dating back to 1995 can be easily derived from the life tables supplied by the United Nations Population Division.

R_b must be divided by 100 because it expresses how many males must be born for every 100 females, and we are deriving a single-digit figure representative of children born to a couple. The numeral 1 is then added to the adjusted sex ratio to provide for the one female who must survive to mean reproductive age. This total is then divided by M_p, which reflects only female survival to mean reproductive age because male survival is, technically speaking, irrelevant to population replacement so long as some significant proportion of males do in fact survive.

We take 27 years and six months to be the mean age of reproduction because the range is generally given in the demographic literature as 25 to 30 years (reflecting the greater number of children that women typically have in the first half of the 15-49 age range), and "near age 27 ½" in Smith. Moreover, this probability is easy to calculate by averaging the probability of female survival to age 25 with the probability of surviving to age 30 in the life tables published by the United Nations, at least since 1995. Mean age of reproduction, too, is among the parameters that deserve further exploration, as the actual value is a variable that can be plotted, given available data, for individual populations.

In his classic work on mathematical demography, Keyfitz (1977) found the mean age of childbearing in the United States to be 26.14 years, using 1967 data. This figure has undoubtedly risen with the increasing age of childbearing in the United States. Moreover, women in developed countries generally have higher mean ages of reproduction than those in most developing countries, many of which have high levels of child marriage and fairly high fertility at early ages. Adjusting for these differences might raise slightly our values for replacement fertility in low-fertility populations and lower them in high-fertility populations. That, in turn, would shrink to some extent the range of calculated replacement fertility rates, now varying from 2.04 to 3.35 children per woman. It is theoretically possible to calculate population-specific mean ages of female reproduction based on analysis of mothers' ages at each birth, but data are unlikely to be available for this calculation in any but a few populations. Nonetheless, such data as do exist would allow some refinement of this important variable in our equations. The tradeoff for abandoning our current mechanism of averaging UN life tables for female survival to 25 and 30 would probably be the loss of an easy calculation that can be standardized for all populations and that anyone can perform.

One challenging question about this methodology is whether to rely on the current synthetic approach to the replacement fertility calculation, which necessarily assumes that all female newborns born today will experience the mortality rates current in each age group today. Wouldn't these mortality rates change with time? Chamberlain and Smallwood propose a calculation they call *cohort reproductive capacity replacement*, based not on current estimated but on the future projected mortality rates for each birth cohort, as indicated in whatever population projection is being used. The result, not surprisingly, is considerably lower replacement fertility rates, since the presumption is almost universal in projections that mortality rates will fall and life expectancy rise.

Calculating the difference between conventional replacement fertility and cohort reproductive capacity replacement for England and Wales from 1924 to just after 1956, they found the latter was lower by about a quarter of a child at the opening of the period and by about a twentieth of a child by the end (Chamberlain and Smallwood, 2005).

There is much to recommend this approach. For one thing, it could be used to "backcast" replacement fertility, and accurately calculate past rates based on the mortality rates that actually unfolded historically, subject to data availability. Moreover, it is logical and true that each infant will experience the mortality rates of her own cohort, not those of her elders at the time of her birth. So why not adopt this more "realistic" approach to replacement fertility, with its more optimistic outcomes? There are several reasons, the least of which is that it is a radical shift from past demographic practice and would make future calculations incompatible with past ones. The main counter-argument can be summarized by the lay principle, "don't count your chickens before they hatch." We cannot know the mortality rates that those born today will experience tomorrow. In particular, we chose not to rely on demographers' assumptions of future mortality because part of our hope for the utility of tracking replacement fertility rates is to investigate whether high or rising rates indicate some departure in young people's mortality rates or, to a lesser extent, sex ratios at birth from those previously projected. There would be no possibility of this if we relied on projected mortality rates for our survival probability inputs.

A more complicated technical issue is the dynamism of the United Nations Population Division's use of life tables, which has changed recently and may continue to change, largely in response to the difficulty of estimating both AIDS and non-AIDS mortality in those countries (currently 60) considered highly affected by the HIV/AIDS pandemic. As the use of anti-retroviral therapy in developing countries spreads, patterns of mortality are likely to change further, perhaps requiring further changes in life tables (UNAIDS Reference Group on Estimates, Modelling and Projections, 2005).

VII. Findings

Table 1 displays the rankings of countries we have derived from the UN population data (United Nations, 2005).

Table 1.

Country, region or other population grouping	Replacement Fertility Rate
Swaziland	3.35
Sierra Leone	3.21
Niger	3.15

Angola	3.11
Botswana	3.08
Afghanistan	3.06
Zambia	3.02
Nigeria	3.01
Liberia	3.01
Lesotho	2.98
Democratic Republic of the Congo	2.95
Equatorial Guinea	2.94
Central African Republic	2.94
Mozambique	2.93
Chad	2.93
Middle Africa	**2.92**
Malawi	2.92
Guinea-Bissau	2.92
Zimbabwe	2.90
Rwanda	2.89
Somalia	2.88
Western Africa	**2.87**
Mali	2.87
Burundi	2.86
Sub-Saharan Africa	**2.81**
Burkina Faso	2.80
Côte d'Ivoire	2.78
Cameroon	2.78
Ethiopia	2.75
Eastern Africa	**2.74**
Tanzania	2.73
AFRICA	**2.70**
Guinea	2.66
Least developed countries	2.66

Southern Africa	**2.62**
Uganda	2.62
Mauritania	2.61
Kenya	2.59
Benin	2.59
Laos	2.57
South Africa	2.57
Namibia	2.57
Djibouti	2.55
Haiti	2.52
Senegal	2.52
Madagascar	2.51
Democratic Republic of Timor-Leste	2.51
Sudan	2.50
Gabon	2.49
Gambia	2.49
Cambodia	2.47
Togo	2.47
Ghana	2.46
Congo	2.46
Papua New Guinea	2.44
Iraq	2.41
Less developed regions, excluding China	2.39
Melanesia	**2.38**
Pakistan	2.38
Eritrea	2.37
Myanmar	2.36
Sao Tome and Principe	2.36
Less developed regions	2.35
Nepal	2.35
Yemen	2.35

South-central Asia	**2.34**
Tajikistan	2.34
India	2.34
Bhutan	2.33
Azerbaijan	2.32
WORLD	**2.32**
Bangladesh	2.30
Solomon Islands	2.30
Turkmenistan	2.29
Other less developed countries (excluding least developed countries)	2.28
Bolivia	2.28
ASIA	**2.27**
Mongolia	2.27
Comoros	2.26
Armenia	2.24
Caribbean	**2.24**
Guyana	2.24
Kazakhstan	2.24
Western Sahara	2.24
Micronesia (Federated States of)	2.23
Uzbekistan	2.23
Maldives	2.23
Northern Africa	**2.22**
North Korea	2.22
China	2.22
Honduras	2.22
Kyrgyzstan	2.22
Georgia	2.21
Eastern Asia	**2.21**
Western Asia	**2.21**
Guatemala	2.20

South-eastern Asia	**2.19**
Indonesia	2.19
Dominican Republic	2.19
OCEANIA	**2.19**
Peru	2.19
Vanuatu	2.18
Turkey	2.17
Nicaragua	2.16
Algeria	2.16
Paraguay	2.16
Suriname	2.16
Samoa	2.16
Viet Nam	2.16
El Salvador	2.16
Micronesia	**2.16**
Morocco	2.15
Belize	2.15
Albania	2.15
Iran (Islamic Republic of)	2.15
Egypt	2.15
LATIN AMERICA AND THE CARIBBEAN	**2.14**
Russia	2.14
Jamaica	2.14
Fiji	2.14
South America	**2.14**
Philippines	2.14
Brazil	2.14
Moldova	2.14
Colombia	2.14
Ecuador	2.14
Ukraine	2.13

Venezuela	2.13
Tunisia	2.13
Tonga	2.13
Central America	**2.13**
Jordan	2.13
Macedonia	2.13
Eastern Europe	**2.13**
Trinidad and Tobago	2.12
Polynesia	**2.12**
Serbia and Montenegro	2.12
Panama	2.12
Belarus	2.12
Bahamas	2.12
Bosnia and Herzegovina	2.11
Romania	2.11
Saudi Arabia	2.11
Occupied Palestinian Territory	2.11
Lebanon	2.11
Mexico	2.11
Bulgaria	2.11
Libyan Arab Jamahiriya	2.10
Thailand	2.10
Saint Lucia	2.10
Latvia	2.10
Syria	2.10
EUROPE	**2.10**
Cape Verde	2.10
Malaysia	2.10
Bahrain	2.10
Oman	2.10
Southern Europe	**2.10**

More developed regions	2.09
Lithuania	2.09
Saint Vincent and the Grenadines	2.09
Ireland	2.09
Uruguay	2.09
Cyprus	2.09
Spain	2.09
Mauritius	2.09
Singapore	2.09
Estonia	2.09
Guam	2.09
Qatar	2.09
Poland	2.09
French Polynesia	2.09
Argentina	2.09
Portugal	2.09
Puerto Rico	2.09
Greece	2.09
New Zealand	2.09
United States Virgin Islands	2.08
French Guiana	2.08
Costa Rica	2.08
Cuba	2.08
Croatia	2.08
Malta	2.08
United States of America	2.08
Italy	2.08
South Korea	2.08
New Caledonia	2.08
Luxembourg	2.08
Netherlands Antilles	2.08

Hungary	2.08
Sri Lanka	2.08
Hong Kong	2.08
Brunei Darussalam	2.08
NORTHERN AMERICA	**2.08**
Israel	2.08
Denmark	2.08
Slovenia	2.08
Slovakia	2.08
Iceland	2.08
Norway	2.08
Canada	2.08
United Arab Emirates	2.08
Germany	2.07
Sweden	2.07
Australia	2.07
Czech Republic	2.07
Austria	2.07
Channel Islands	2.07
China, Macao Special Administrative Region	2.07
Barbados	2.07
France	2.07
United Kingdom	2.07
Australia/New Zealand	**2.07**
Northern Europe	**2.07**
Netherlands	2.07
Switzerland	2.07
Belgium	2.07
Japan	2.07
Martinique	2.07
Western Europe	**2.07**

Chile	2.07
Finland	2.07
Guadeloupe	2.06
Kuwait	2.06
Réunion	2.04

Among the first lessons we learn is that 2.1 children per woman is not a good approximation of replacement fertility in human population — and, since mortality rates have been declining for centuries, it never has been. The number applies quite accurately to Europe as a whole, and with a bit less precision to the world's more developed countries. But less than one fifth (19.4 percent) of the world's population lives in countries in which replacement fertility is actually 2.1 children per woman or lower. The world's average replacement fertility rate is 2.32 children per woman, similar to the average in Asia (2.27) and much lower than that of sub-Saharan Africa, where the rate (2.81) is not much below three children per woman.

We see a surprisingly large range of values for this indicator, from as low as 2.04 (Réunion, suspiciously low and perhaps not to be trusted, as the country's sex ratio at birth is reported at the anomalously very low ratio of 101) to as high as 3.35. Using the national rates of 2.06 as the low values, the variation from this to the highest value is 61 percent.

Nine nations, all in sub-Saharan Africa except for Afghanistan, have replacement fertility rates greater than 3, meaning that women in these countries must give birth to three children to have confidence they and their partners are replacing themselves in the populations. Two of these nine nations have only recently joined the over-3 group, due to recent increases in AIDS mortality among young women. A third country with high AIDS-related mortality, Lesotho, has a replacement fertility rate only insignificantly below 3. Other countries with the world's highest replacement fertility rates, however, have only modest HIV prevalence (Niger, 1.2 percent of reproductive-age adults) or very low levels (Afghanistan, no data, but believed low). This raises the question: What are the forces in these countries so fatal to girls and young women?

We find that young female mortality, expressed by the probability a newborn girl will survive to 27.5 years, is by far the most important variable in the calculation. The contribution of sex ratio at birth seems less influential in raising or lowering replacement fertility, except perhaps in extreme cases that may be limited to regions within countries. Reliable data is notoriously sparse for this important demographic indicator, but if we rely on UN data we find only a handful of countries with sex ratios at birth sufficiently outside the normal range to raise the suspicion of sex-selective abortion. Perhaps foremost of these is China, with a sex ratio at birth of 110 in 2005 and a replacement fertility rate of 2.22. If China had had a normal sex ratio at birth of 105, the replacement fertility would have been lower, at 2.17 children per woman, but not by much. It is possible, of course, that in China's case, as in those of other countries, relatively high mortality of girls and sex-selective abortion may both stem from abysmal status for daughters relative to sons in many families.

The most extreme examples of reported high sex ratios at birth apply to sub-national rather than to any national populations. As an exercise to consider the hypothetical impact of extreme sex ratios at birth on replacement fertility rates, we considered the case of the Delhi National Capital Territory in India. In their book *Bare Branches*, Valerie Hudson and Andrea den Boer cite a reported sex ratio at birth of 123 for this area, a ratio unlikely without parental intervention through sex-selective abortion. Our calculation of replacement fertility for India as a whole is 2.34, based on a UN-reported sex ratio at birth of 105, a ratio at precisely the world average. If we assume Delhi's life tables are identical to those of India's (survival rates may actually be higher, since access to health care services is presumably better in the urban capital setting), we find that Delhi has a replacement fertility rate of 2.52, a bit less than a fifth of a child higher than India's as a whole. This is scarcely negligible, but it is instructive that the range of possible replacement fertility rates worldwide ranges by an amplitude equal to about 1.3 children, whereas the range of differences in this rate based on sex ratio at birth seems to have an amplitude no larger than about 0.2 child.

Thus we must temper any assumptions that replacement fertility can tell us very much about son preference. Certainly, it is less expressive than sex ratio at birth itself, also a single number. Nor is the prevalence of sex-selective abortion more than one indicator of gender status, and a particular kind of gender status — son preference — at that. And son preference is at best only one indicator of a much richer, hard-to-quantify concept variously generalized as gender status, women's empowerment, female autonomy or a variety of other terms. Female status is abysmal in many societies in which sex-selective abortion is unknown. At best, the contribution of sex ratio at birth to the calculation of replacement fertility rates adds a very modest element of gender, related to son preference, to an overall calculation that says much more about the overall precariousness of life for young females, from before their births to their late twenties. A disaggregation of replacement fertility rates by their component parts may still tell us much about female status in societies, especially if and when high sex ratios at birth combine with anomalously high mortality rates of girls under 5 years old.

We performed only limited calculations on temporal changes in replacement fertility rates. (The United Nations Population Division only began including life tables in the biannual publication *World Population Prospects* in its 2000 revision.) What we found suggested that tracking these changes into the future could indeed be revealing. As demographers would predict, given the general downward trend in mortality rates, most country's replacement fertility rates appear to be converging on the 2.05 to 2.1 range. In a few cases, however, replacement fertility is rising. Uniformly, these are countries highly affected by HIV/AIDS. Botswana, Lesotho and Swaziland all experienced rising replacement fertility rates from close to 2.5 to 3 or higher between 1995 and 2005; rates are expected to stay relatively flat until beginning a decline between 2010 and 2015.

An examination of their mortality rates by age shows that, as could be predicted, the risk of dying has soared for women in tragically young age groups. In each of the three countries mentioned above, the percentage of women in each age group who die between the ages of 25-39 has increased from less than 1 percent in 1980 to between 5 and 11 percent in 2005.

VIII. Implications

In 2003, demographers at Princeton University's Office of Population Research noted the wide variation in global replacement fertility, but they used this variation to make the demographic point that many governments targeting total fertility rates of 2.1 might find their populations in decline if that target were reached while replacement fertility rates remained above 2.1. This message seems out of tune with the current policy focus away from total fertility targets that has prevailed at least since the United Nations International Conference on Population and Development in 1994. It is also unrealistic from a demographic and health policy viewpoint. Clearly, those countries able to provide the reproductive health services required for fertility rates to reach 2.1 will also see increases in the survival of girls and women, and possibly in birth ratios as well, that will allow replacement fertility to converge at or below that figure.

This underlines a key point: Variability and evolution of replacement fertility rates are important not so much as a way to bring attention to the need for a stable global population — although there is a place for that discussion — but as a simple indicator of global health and development consonant with the evolution of the population and reproductive health fields. Lower levels of replacement fertility stem from lower rates of sex-selective abortion and mortality among girl children and young women. These, in turn, strongly suggest increased access to health care services, reduced stigma in being born female, and generally higher levels of development and quality of life.

Replacement fertility includes and expands on infant mortality rates, a commonly cited indicator of basic health in developing countries, by tracking the survival of girl babies all the way to their late twenties and by incorporating the existence in some countries of sex-selective abortion due to low female status. For the population and demographic community, a focus on replacement fertility variability has added benefits. While educating ourselves and our audiences about a key fertility variable, we will also be exploring the other side of the demographic transition: survival and long life. Without undermining the importance of family planning and reproductive health, the variability of replacement fertility reminds us that all aspects of health, sanitation and environmental well-being relate to population change as well. Moreover, consideration of replacement fertility helps us clarify other key population-related points to policymakers. In an era of HIV/AIDS and other growing risks to the young, it is no longer appropriate simply to call for global "population stabilization" and "slowing world population growth" without expanding this message, as these outcomes may stem in part from rising death rates and skewed sex ratios at birth. Any such goals should arise as completely as possible from falling birthrates related to the childbirth intentions of women and couples.

Replacement fertility can tell us much more than simply what total fertility rate is necessary to reach population equilibrium. What proportion of females die before reaching young adulthood, for example, and at what ages — and why — do they die? To what extent does high replacement fertility stem from a high sex ratio at birth (significantly more male babies born than girl babies), and what is behind that? Is rising prevalence of HIV infection among teenage girls in developing countries beginning to raise replacement fertility rates (at the same time that HIV infection may depress fertility itself)? To what extent are AIDS, malaria and other infectious diseases boosting rates of infant, child and maternal mortality? Such questions can be explored, aired and discussed through the elements that make up the replacement fertility calculation in each country. The discussion not only will reacquaint the population community with this important variable, it can expand the understanding of the concept's value to the broader public health and development community.

The concept also provides a way to monitor how demographic reality is according with demographic projections. The UN and other population projections assume steadily improving life expectancy, but this may be a kind of "faith-based" demography. Certainly in those countries most severely ravaged by HIV/AIDS, life expectancy is heading in the other direction. Even in these cases, however, UN demographers assume the high death rates brought about by the pandemic will ease and return to normal levels. Plotting projected replacement fertility rates for some of these countries, we see that they are presumed to once again converge on values little above two children per woman. Even Swaziland, with the highest current replacement fertility rate in the world of 3.35, is expected to decline to a replacement fertility rate below 2.5 in 25 years and to reach 2.2 by 2050.

Tracking the actual change in replacement fertility rates in these countries is one way to put a human face on these public health emergencies. Until replacement fertility peaks and begins a decline, couples must consistently give birth to more children — often as many as three or even more on average — just to replace themselves in their nations' populations.

We propose as a goal of the public health and development communities that all countries achieve and maintain low replacement fertility for all time. An appropriate task for those who work on population and health is to track replacement fertility rates for all countries, comparing actual rates to those projected by the United Nations Population Division and other demographic agencies. Where actual replacement fertility rates exceed those projected, those who care about the sustainability of human population dynamics have good reason to be interested and to call the attention of policymakers to the possibility of developing demographic, health and development reversals.

Those who advocate on population-related issues can improve understanding of their work by making the ironic point that there is still a need for government targets related to fertility, but only a specific kind. Let total fertility rates wander where they will based on the informed decisions, implemented in good health, of women and couples about whether and when to have children. Replacement fertility should, by contrast, "stop at two" (almost). An important goal for long-term public health should be to bring and sustain replacement fertility as close as possible to 2.05 children per woman, a value that would be based on normal sex ratios at birth and essentially zero probability that newborn infant girls would die before their late twenties. This message could help frame the many diverse aspects of population-related work, to support progress in human health and development, to help alleviate poverty, and to support sustainable human relationships with the natural environment by making sexual and reproductive health and rights a reality for all people.

Indeed, we see the potential for a fresh strategic and thematic indicator that can tie together disparate aspects of the work of the population and reproductive health fields and help answer perhaps the most important questions of all: What are we in the sexual and reproductive health and rights community all about? What are we working for? Replacement fertility helps us see plainly that we are not in the business of counting people or blaming them for bearing or being children, but rather of helping to assure life, health, gender equity and environmental sustainability — in a word: survival. Our work is to bring closer a world in which all human beings live to enjoy their rights to full and fulfilling sexual and reproductive health, for as long into the future as we can see.

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